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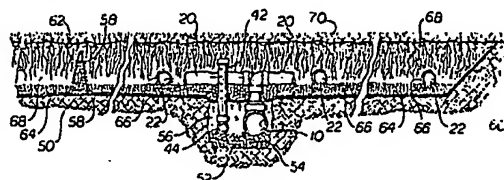
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54 Grass sports surfaces and a method for maintaining them.

57 A level unobstructed grass sports and recreation surface wherein the grass is deeply rooted in a layer of sand overlying a layer of gravel and preferably nurtured from below to provide a controlled growing environment exhibiting vigorous growth. The sand has more positive vertical liquid flow characteristics whereas the gravel has better horizontal liquid flow characteristics and the appropriate gradation selection of both determines the high drainage ability and uniform fertilizer/irrigation distribution throughout the system. The grass surface is defined by a water tight membrane (58) extending from the perimeter adjacent the surface and completely underlying the gravel layer (64). Control means are provided to detect the liquid level contained within the membrane and add or remove liquid to maintain the appropriate level. The buried conduit system is used for the controlled addition of water/fertilizer and excess drainage removal. The nutritied liquid from the reservoir is hydroponically supplied to the roots of the grass on a continuous demand basis. Heating cable may be placed at the boundary zone on top of the gravel and sand layers to warm the sand to remove frost and melt snow. An insulation layer may be placed beneath the membrane to minimize frost penetration to the subgrade. The system may be either completely automatic and programmed to accommodate external conditions such as degrees of use of the field, climatic conditions or

the like or alternatively may be partially automatic and supported by more standard methods.

Coupled with the control system can be a sensing unit to determine automatically the nature of the contained liquid.



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As is well known, the construction of a good quality all weather grass playing surface and its maintenance for recreational purposes and active sports, such as soccer and football, has been a problem of long  
5 standing.

One of the more recent attempts at resolving this problem has resulted in use of an artificial surface. These surfaces have reduced the regular maintenance required but the cost to repair for wear  
10 and tear generally exceeds the cost of maintenance of a natural grass field. Further, the playing conditions immediately over a synthetic surface are far less tolerable than over a grass surface since the synthetic and its supporting surface retain heat. All synthetic  
15 surfaces have suffered from the inability to provide adequate drainage. In general, these synthetic surfaces are not completely acceptable to player associations since they have a higher incident of injury than that experienced on a good quality natural grass surface.

20 In general, the factors which must be considered in designing and maintaining a playing surface include

the needs of the player utilizing the surface, the requirements of the agrologists in plant growth and maintenance and the correct application of acknowledged engineering principles. The finished product will  
5 experience variable and sometimes unpredictable environmental considerations. The total growth and maintenance system must have a flexibility built into it such that the variables may be accommodated.

The selected grass used must be of a type which  
10 has good wear ability characteristics, but also must satisfy the climatic conditions in the locality where it is to be used. Once the selection has been made as to the seed mixture, the plant itself must be established and must be capable of vigorous growth to provide for  
15 rapid self-repair following user damage. The grass must be well anchored in its growing medium to minimize tear out by the participant and it should provide a uniform surface throughout the applicable season.

It is desirable that the quality of the surface  
20 be constant for the entire grassed area and that the surface be able to be used extensively even under adverse climatic conditions. This desire obviously requires the surface be free from an accumulation of water and frost and that the watering and fertilization appli-  
25 cation do not interrupt use. The ground conditions should be firm and yet provide a cushion normal for a well established turf which experience has shown to minimize player injuries.

It is further desirable that the playing area should be free from obstructions such as sprinklers or the like and reasonably level throughout its entirety.

Maintenance personnel require a minimization  
5 of the operational function needed to maintain the surface while retaining a good quality grass condition.

In general, grass surfaces heretobefore provided can be generally classified as the soil turf field, the modified sand field and the membrane sand  
10 field.

The soil-turf playing surface is a classical method wherein the growing medium is a natural good quality soil placed over a granular material. Drainage is provided by providing a crown to the surface and  
15 subsurface drains. Irrigation is applied to the surface by conventional methods. Fertilizer is generally applied to the surface through mechanical spreading or through sprinkler applied liquid fertilizer.

These soil-turf fields in general do not stand  
20 up to more than minimal use and require heavy maintenance. In wet locations, these fields are consistently muddy due to poor drainage characteristics whereas in dry conditions, the grass shows the effect of the heat and in general are not well nourished. In hot locations,  
25 surface applied irrigation experiences large evaporation losses to atmosphere and a build up of water borne impurities at the surface damages the grass. Surface compaction caused by the natural rainfall, surface

irrigation and player use generally renders the drainage system ineffective. The compaction also prevents oxygen from reaching the roots and inhibits growth. The surface runoff attempted by crowning the field is  
5 not rapid enough even under minimal rainfall. The grass plants are generally surface hugging because of the fact that the water, nutrients and oxygen required are all located there. In this weakened state, the grass may be easily pulled out during normal play, creating  
10 bare areas which are not readily self-repairable and require extensive resodding. A weakened grass is more susceptible to disease and infestation problems. This method does not lend itself to soil warming techniques since the melted frost and snow aggravates the lack of  
15 drainage and turns the surface to mud. In cold climates, the surface freezes rapidly due to the high silt content and its moisture retaining characteristics.

The inadequacy of the soil turf method has led to development of both the modified sand and the mem-  
20 brane sand methods. In each of these cases, the primary attempt is to overcome the drainage and compaction problem.

The modified sand method uses two classifications of sand as a growing medium, i.e. a bottom layer  
25 of natural clear sand while the top surface is a mixture of sand and organics. Drainage is provided by an underlying grid and irrigation and fertilizers are surface applied by the same means as for soil turf method.

The modified sand method has essentially uncontrolled drainage through the sand layer and therefore the modified surface zone is essential to avoid drought conditions at the level of plant growth.

- 5 Although the addition of organics retain the nutfied moisture and oxygen relation in the surface layer for good plant growth, the organics also retain water, slow down the drainage rate and result in a soft and slippery surface. The grass is surface hugging for the
- 10 same reasons as the soil turf field. A major problem in this method is lack of long term control. The surface zone, although selected for proper liquid retention characteristics at the time of design, is subject to normal decomposition and leeching of the
- 15 organics resulting in their loss through the drainage system. Further, the decomposition of the organic material consumes nitrogen necessary for strong healthy growth. The eventual replacement of the organics is impossible without entire replacement of the surface
- 20 layer, an expense similar to resodding for the soil-turf field. The effectiveness of soil warming techniques to remove snow and frost are inhibited by the lack of the systems ability to continuously replace lost moisture caused by the cold weather drying effect. The surface
- 25 condition results in freezing conditions similar to the soil turf field.

The membrane sand method is the result of efforts to capitalize on the principles of hydroponic

growth, which has proven to be totally successful with a controlled propagation of plants in a nursery environment. Although variations exist, in general, the sand method membrane/comprises of a natural sand growing medium

- 5 which is completely isolated by an impervious membrane to provide a contained reservoir of water and isolate the area. Over the membrane and within the isolated area is placed the pipe or conduit system which is tied into a drainage discharge system located outside
- 10 the field area to allow removal of excess water. Over and around the pipes are placed sand and the regulation of the excess drainage discharge is provided by some form of weir like action or pumps or both.

- These systems have not been adequately
- 15 designed to properly handle sub-surface applied irrigation or fertilizer and generally those installed use surface sprinkler systems and fertilizer application by means similar to the soil turf and modified sand methods. The majority of installations have also used a modified
- 20 surface zone by including a layer of organics. This effect minimizes the capillary action (a benefit of the membrane) since capillary rise will not readily transfer from the pure sand to the modified sand thus creating a barrier and necessitating supplementary
- 25 surface applied irrigation and fertilizer. Those with perforated distribution pipes placed directly on the plastic membrane are impaired since the standard location of the perforation holes and the normally expected one inch ground settlement after construction

causes some of the pipes to indent into the plastic .  
blocking the holes and making them ineffective.

Pumps used to assist in the removal of excess drainage water are ineffective when the water table is below  
5 the entry parts of the pipes due to loss of vacuum.  
Installations using special piping cross joints have  
shown irregular drainage capabilities due to restricted  
flow. Systems using only sand exhibit poor lateral  
liquid movement to or from a pipe system and require a  
10 larger head pressure for drainage. Under certain  
conditions, the head requirement results in a saturation  
curve within the sand that will intersect the  
surface between the pipes and cause surface puddling.  
Conversely, liquid attempting subsurface entry into the  
15 field is restricted in uniformity of distribution unless  
sufficient pressure is used which could then lead to a  
quick sand condition in the areas of the initial entry  
points. None of the systems exhibit positive and  
responsive control systems.

20           Although a search has not been made, U.S.  
Patent Number 3,461,675 granted to Izatt on August, 19  
1969 is illustrative of the type of system described  
hereinabove and improved upon by the present invention.

          The important criteria of this improved  
25 membrane sand system is to provide and maintain a deep  
rooted grass surface which exhibits vigorous growth  
and which has a level surface throughout without obstructions  
and which does not suffer compaction problems.



The system is capable of minimizing environmental problems created by variable climatic conditions of the various locales in which it is installed includes effective surface drainage abilities as well as

5   nutrified liquid replacement to the plants growing zone on a uniform and continuous demand basis as the plant and climatic conditions dictate. Soil warming techniques for frost and snow melting create surface drainage and plant drying out effects and the system

10   is capable of handling these factors.

          The prime consideration of this improved membrane sand system is to control the water table within the isolated membrane area and the assurance of uniformity of lateral distribution of the nutrified

15   liquid reservoir such that the surface zone moisture content is maintained. This control and distribution ensures the proper relationship of nutrified water and oxygen for the particular sand type and within the tolerance limits for the plant. Water and nutrients,

20   whether applied by subsurface means or at the surface, move freely to the membrane reservoir by the excellent vertical drainage characteristics of the sand. This reservoir in turn feeds the grass plant by capillary action inherent with the sand. Excess water occurring

25   during rainfall is discharged out of the system, conserving first any rain water than can be retained for irrigation purposes. Irrigation water make-up is preferably applied through the utilization of a sub-

surface pipe grid utilized for both the drainage and the irrigation or may be applied by conventional surface means. Fertilizer is added to the irrigation water using liquid fertilizers and an injection system or may  
5 be surface applied.

It has been well demonstrated that depending upon passage of time and as a characteristic of a selected sand, the sand absorbs the same amount of liquid whether or not it is applied at the surface or from  
10 beneath. It can also be easily demonstrated that the absorption of the sand is proportional to its depth and the moisture content at any level can be determined as a function of the depth of a particular gradation of sand.

15 The capillary rise in the sand, in addition to the drainage characteristics, is dependent upon the gradation and makeup of the sand and is controllable by proper selection of these materials and the establishment of a water table. The rate of capillary rise.  
20 is particularly critical in extremely dry climates and the drainage rate is critical in areas of heavy rainfall. It is also required that the selection of the gravel be such that its gradation, in comparison with that of the particular sand, be compatible to ensure that the  
25 sand will penetrate the gravel layer by a depth of approximately one inch. This penetration places the bottom of the sand layer below the minimum water table to allow capillary action and yet the lateral flow

characteristics of the gravel are not impaired.

It can thus be seen that maintaining a water table at the bottom of a natural sand layer permits the more accurate control of the moisture content at the growing level. Further the natural sand surface extends the playing season by its low moisture retention and thus its ability to hold back freezing for a slightly longer period and to thaw out more rapidly. The dormant period of the plant is thus reduced. The addition of a uniform heat source, combined with the proper seed selection, may further extend the season by encouraging early growth and resisting die back caused by cold. The inclusion of an insulation layer under the membrane will minimize frost penetration to the subgrade at times when the heating system is not in use.

In summary, an accurately controlled, frequently watered, properly fertilized well drained field provides for the best quality grass playing surface as well as encouraging rapid regrowth and thus providing maximum utilization. Healthy plants are less susceptible to disease and infestation and a natural grass surface provides much lower air temperatures immediately over the playing surface than the prevailing ambient conditions while providing the immediate air with an enrichment of oxygen. Only this improved membrane sand method with automatically operated subsurface drainage and fertilization in combination with irrigation, i.e. "fertigation," provides these requirements on a continuous demand basis

as determined by the plant and the environment. The grass itself, in growing, has a deep rooted characteristic as it reaches down to the water table and thus has better wear and tear capabilities, since the plant is more firmly anchored and thus suffers only leaf damage during extensive use which is rapidly replaced by vigorous regrowth. The utilization of "fertigation" by subsurface application is a continuous, uniform and steady means which when coupled with the membrane isolated area, carefully selected growing medium and liquid transfer medium and system coupled with accurate and responsive control method provides these requirements.

It is an object of the present invention to provide a playing surface support material and method which maximises the utility of a field and minimizes the maintenance requirements under the most variable and severe climatic conditions.

Still a further object of the present invention is to provide a system for establishing and maintaining a grass play surface comprising the steps of: (1) grading the subgrade at the site of the proposed surface, (2) placing a fluid impermeable membrane adjacent the graded surface with or without inclusion of an insulation layer, (3) providing means of central supply and removal of fluid at the appropriate location in the graded surface, (4) providing a layer of horizontal flow gravel on top of the membrane, (5) placing a lateral liquid distribution

system throughout the desired area on top of the gravel layer, (6) providing a layer of sand with appropriate permeability, capillary and porosity characteristics and having a substantially level upper surface without  
5 obstructions into which the grass will be planted, (7) provide a means exterior to the field to direct excess drainage water from the field to the site storm system, (8) providing a responsive control system to control the liquid level within the confines of the membrane beneath  
10 the grass, (9) provide an adequate fertilizer injection and water make-up system to sustain optimum growth and replace transpired and evaporated water, (10) provide a drain line to remove all liquid from the contained reservoir, (11) when required, installation of a soil  
15 warming system to melt snow and remove frost, (12) when required, to provide a means to sense the nutrified condition of the contained liquid.

Still another object of the present invention is to provide a membrane sand type grassed sports  
20 surface including automatic means to provide irrigation as needed, provide fertilizer on a predetermined schedule, and to withdraw liquid from the field in the event that the level within the membrane exceeds the maximum desirable for optimal utilization of the field  
25 while maintaining the quality and quantity of nutrified liquid to stimulate healthy growth.

It is another object of the present invention to provide a grass playing field which includes a

growing medium having predictable capillary action  
overlying a liquid containing material having horizontal  
flow characteristics assuring uniformity of distribut-  
ion under low infeed pressure requirements in which are  
5 placed conduits for the addition of water and fertilizer  
to the liquid reservoir.

A still further object of the present invention  
is to provide a grass supporting medium wherein the  
upper layer provided a firm noncompacting surface with  
10 predictable permeability permitting ready drainage and  
an underlying surface permitting lateral fluid movement  
such that a minimum head is required to effect the  
drainage.

Still another object of the present invention  
15 is to provide a means located within the field beneath  
the grass sports surface for determining the level of  
liquid within the grass supporting medium interconnected  
with a means exterior of the field to provide ready  
and convenient information as to the liquid level.

20 It is another object of the present invention  
to provide a means and mechanism to sense the system's  
water level and magnetically transmit this into low  
voltage electrical signals and relays these to a pro-  
grammable control panel which, in turn, operates, using  
25 a low voltage power supply, the irrigation infeed and  
drainage outflow valves. The system utilizes available  
irrigation water pressure to function the main valves  
through small solenoid valves located on the bleed lines

from the irrigation line. This method thereby minimizes any electrical hazard.

It is another object of the present invention to provide a means and mechanism when electrical energy is not available to use float operated devices activated by the systems water table and coupled to the irrigation bleed line valves to transmit the irrigation pressure into a force to open or close the irrigation and drainage valve.

A further object of the present invention is to provide a means and mechanism for extending the usable season for a playing field through the use of underground heaters and protective sub-grade insulation layer combined with a system which accommodates the generated drainage requirements while simultaneously providing a continuous source of liquid to avoid the drying effect normally associated with artificial heating devices.

Yet a further object of the present invention is to provide a grass field which may have a chemical imbalance corrected without resorting to a restructuring or replacement. A drain and irrigation system is provided such that all chemicals or the like may be easily washed by means of purging from the grass supporting medium effecting a neutral condition. It is also the object of the drain to allow removal of all liquid from the entire system when necessary.

Figure 1 is a plan view of a typical field

layout utilizing the present invention.

Figure 2 is a sectional view taken along the lines 2-2 of Figure 1.

Figure 3 is a plan view of the preferred  
5 control room.

Figure 4 is an elevational view of the water supply header as seen along lines 4-4 of Figure 3.

Figure 5 is a plan view of a valve station.

Figure 6 is an elevational view of a valve  
10 station.

Figure 7 is an elevational view of the electrically sensed level control unit.

Figure 8 is a flow diagram for an automated system.

Figure 9 is an elevational view of an alternate  
15 mechanically sensed level control unit.

Figure 10 is a sectional view of an alternate construction when heating and sub-grade insulation is included.

20 As seen in Figure 1, the field generally designated as 2 is divided into three essentially equal sections 4, 6 and 8 and defined internally by a division along lines 62. It is to be understood that the size and



shape of the field as well as external conditions such as climatic factors and degree of use will determine the number and shape of the sections. Each section has a slope in the sub-grade designated in diagonal lines 3 to a low point at approximately the center of the section where the water level detector 42 will be located as explained hereinafter. Within each section of the field there will exist a field section main 10, 12 and 14 interconnecting with the required number of horizontal field distribution piping headers 16, 18 and 20. A plurality of perforated field distribution pipes 22 form a substantially equally spaced grid work throughout the field assuring reasonably equal distribution and/or saturation.

Each of the sloping field section mains 10, 12 and 14 are connected to a valve station 24, 26, 28 located below grade outside the playing area and are interconnected by means of an irrigation feed system 30 which is interconnected with and controlled from the control room 32 which in turn is connected to the water supply 34. These field distribution pipes 22 and the headers 16, 18 and 20 as well as the mains 10, 12 and 14 may also be used to discharge excess water by means of the drainage system 36, 38 and 40 which lead to an off site storm system. It is to be noted that the water level detector 42 and its interconnected tube 44 (one for each section) likewise is interconnected with the valve

station and with a storm drain after passing through  
the water level sensing unit 110. Also seen in this  
view is the low voltage electrical control system  
designated generally as 46 from the control room to  
5 each one of the valve stations.

Referring now to Figure 2 which, as noted  
above, is a vertical sectional view taken along lines  
2-2 of Figure 1, it can be seen that the field includes  
a subgrade 50 which slopes within each section towards  
10 its center and the water level detector 42 which can  
also act as a drainage means. At midpoint of each  
section is located the trench 52 to accommodate the  
piping exiting for each section and includes sand bedding  
54 supporting the field section main 10. The water  
15 table level tube 44 is also placed within trench 52  
which is terminated at the center of the section with a  
vertical perforated tube designated as the water level  
detector 42. The remainder of the trench is filled with  
onsite material 56 and a membrane 58 is placed over the  
20 sub-grade and sealed at the conduit entry points thus  
establishing an enclosed dish-like area for the irrig-  
ation and grass support purposes. As the trench exits  
the perimeter of the system a 5 foot long plug using  
impervious materials is inserted in the trench to ensure  
25 a positive seal to the trench itself.

As noted above, the entire field is broken into  
field sections. The field sections are defined by a

perimeter berm 60, which extends around the entire periphery of the field, and upwardly extending section divisions 62 extending across the field and across which the membrane 58 is folded. The subgrade 50, as noted  
5 above, is sloped toward the center of each section but the gravel layer 64 which lies thereupon and supports a perforated field distribution piping 22 as well as the piping headers 20 has a horizontal or level upper surface. It is to be noted that this surface in general  
10 will define the minimum water level through the weir action of the perforations in the event of automatic control shutdown. The gravel layer with horizontal flow characteristics assures even distribution of water or fertilizer.

15           The perforations of the field distribution piping are placed downwards on top of the gravel and the pipes are then covered with a filter cloth wrapping 66. This cloth is standard to earth work projects and prevents the fines loss from the sand from entering the piping  
20 system. The pipe is not entirely wrapped but is covered with the filter cloth which is then tucked on each side of the pipe with the edges projecting outward by three or so inches. This method of wrapping is essential since wrapping the pipe on its entire circumference could lead  
25 to clogging through salted out fertilizer particles being trapped in the filter material 66. The method employed allows the holes to remain uncovered while the sand is prevented from entering the pipe without first

passing through the gravel 64. This is not possible because of the particular selection of the gravel gradation. The sand layer 68 is then placed, overlying the gravel and the distribution piping. The grass 70  
5 is planted at the top of the sand layer at the field elevation which is level throughout. The root structure will generally extend vertically downwardly to reach the established water table and not bunching toward the pipes.

10 As seen in Figure 3, the preferred embodiment of the control room is shown. For ease of cleaning, the control room includes a floor drain 80 at the intersection of the various portions of the sloping floor 82. Mounted about the perimeter of the room is fertilizer storage 84  
15 and control panel 86, the required breaker panel and disconnect devices 88. Mounted upon the floor of the control room is the fertilizer holding tank 90 which has mounted adjacent thereto the fertilizer injection pump 92 for selectively injecting the fertilizer into the  
20 irrigation feed 30 as explained in greater detail with respect to Figure 4.

Referring now to Figure 4, which is a sectional view taken along lines 4-4 of Figure 3, it is seen that the water supply 34 is located beneath grade, is elevated  
25 into the water supply header which includes a wash down hose connection 94, back flow preventer set 96, a strainer and clean out 106, a pressure regulator 98, a test pressure gauge connection 108, a fertilizer injection

valve 100 and a pump purge feed connection 102, in addition to manual isolating shutoff valves 104.

In Figure 5, a plan view of a valve station, there can be seen that the water level tube 44 extends  
5 into the water level sensing unit 110, as described in greater detail hereinafter, and is connected by means of a conduit to the automatic field drain valve 112 which can, as the name implies, be used to remove all liquid from the field as may be required for purging. Just  
10 before the automatic field drain valve 112 is a vertical water level sight tube 111 complete with a colored float and transparent casing to allow for visual inspection of the water table level within the field section. Also extending into the valve station is the field section  
15 main 10 which at its termination has located an automatic drainage valve 128 which, when open, allows excess water to discharge to the site storm system. The liquid make-up supply to the field section main 10 is through the irrigation feed 36 which includes an irrigation feed line  
20 drain 116. Also to be noted in view is a bleed line 118 for pressure assisting the automatic valves.

Looking now at Figure 6, which is a sectional view taken along lines 6-6 of Figure 5, it can be seen that the valve station lies below the field elevation and  
25 as noted in Figure 1, is outside the playing boundaries and further, outside the boundaries of the controlled field. The valve station includes a closing cap 120 and is surrounded by means of a rigid side 122 and a floor 124.

As seen in this view, the water level tube 44 extends outwardly generally toward the field and within the man-hole chamber it terminates with the automatic drain valve 112 which is immediately preceded by the water level sight tube 111. The field section main 10 as seen in this view, lies immediately in front of the water level tube 44 and terminates with the automatic discharge valve 128. Further to be seen in this view, is the irrigation supply to the section main 10 following the irrigation feed line drain 116, shown in Figure 5, is a strainer and clean out 119, bleed line shut-off 118, automatic irrigation supply valve 126, a balancing valve 127 and a test pressure gauge connection 129. The discharge to the storm system is designated 36.

The water level sensing unit for use in the totally automatic system is seen in Figure 7 and as seen, this also lies beneath the field elevation and is covered by a removable cap 130 which covers a vertically placed PCV pipe 132. A plurality of reed switches 134 are mounted and sealed in a vertical member 135. A bouyant toroidal shaped float 136 having permanent magnets 137 embedded therein closes the reed switches 134 by magnetic flux which opens and closes the LV=low voltage electrical switches in the terminal base 138 which relays a signal to the main control panel which in turn actuates valves to add or remove liquid from the field. The liquid level within the water level sensing unit is directly responsive to the level within the field. This unit in conjunction

with the water level detector 42 and the interconnecting conduit 44 form a U-tube. Tube 44, lying at the lowest portion of the section may be used as a drain for purging the field by opening the automatic field drain valve 112 shown in Figure 5 and located within the valve station. Further to be seen in this view, is the connection with the low voltage electrical control system 46 and the conductivity sensor 139 for relaying the condition of the nutrified liquid.

10 As seen in Figure 8, the flow diagram is generally divided into two sections (A) which is generally within the valve station and (B) which is generally within the control room. As seen in this view, the water enters the control rooms by means of conduit 34, passes 15 through the back flow preventer 36, pressure regulator 98, and then for purging of the pump, an auxillary line is fed to the fertilizer injection pump 92 with the main line proceeding after the injection valve 100 directly to the valve station via conduit 38. Fertilizer from the 20 holding tank 90 is automatically directed to the fertilizer pump 92 and then through line 38 to the valve stations. Also seen in this view, is a means to purge the pump to the sewer or to dump the storage tank. Within a typical valve station the water passes through the 25 irrigation supply valve 126, the balance valve 127, and then to the field section main 10. The feedback demonstrating a need for water is generated by the water level sensing unit 110. Further to be seen in this view, the

electrical supply passes through the power panel 88,  
the master irrigation control 86, and is fed to the  
various valving, pumps and water level sensing units  
necessary to perform the functions as described herein-  
5 above. It is to be remembered that all power except  
for the pump is low voltage.

A preferred control for a system when electrical  
power is not available is shown in Figure 9. This  
installation provides for a mechanically automated system  
10 employing a completely controlled method for subsurface  
drainage and irrigation. With this system, control room  
is not required and is replaced with a water supply  
header and an automatic fertilizer application is not  
contemplated and thus is not included. The control  
15 utilizes mechanically functioning float activators 152  
linked by parallel linkage 154 to floats 156 all mounted  
within a manhole 158. A water level tube 44 continues  
through the control manhole and terminates as for the  
automatic system in the valve station with a water level  
20 sight tube 111 and manual drain valve 162. The float  
activators utilize the water pressure from the irrigation  
line through bleed lines 164, 166 and 168 to open and  
close the pressure operated irrigation and drainage  
discharge valves.

25 Figure 10 illustrates, for full disclosure, and  
alternate embodiment of the extreme right end portion of  
Figure 2. Heating cables and a sub-grade insulation  
barrier included as well as a modified periphery of the



field. As can be seen, the insulation layer 200 is placed directly under the membrane over the entire field area. At the perimeter this insulation is carried vertically downwards to a location at least 6 inches  
5 below the contemplated frost penetration for the locale. The exterior perimeter is trenched 202 to accommodate the insulation and a standard type perimeter drainage system 204. The drainage pipe 204 is bedded on sand 206 and the entire excavation is backfilled to within 6 inches  
10 of the surface with free draining select granular fill 208 to ensure elimination of frost heave problems. The surface of the backfilled trench is graded with 6 inches of top soil 210 to support grassing. Referring to the detail within the membrane isolated area, it can be  
15 seen that the heating cable system 212 is located over the gravel layer and under the sand layer. The controls for the soil warming system include ground temperature sensor 214 and relay signals back to the main panel in the central room to ensure gradual heat elevation and  
20 reduction controls using solid state devices such that the grass root system is not subjected to thermal shock. The heating system when combined with the sub-grade insulation may be used intermittently or continuously throughout the winter as user requirements and economics  
25 demand.

Although the completely automatic system has been described in detail, it is to be understood that many of the operations may be handled manually in any one

of several combinations. In extremely cold climates, the installation may be enhanced through the use of an insulated membrane or heaters, if necessary as pointed out above. If necessary, the insulation may be used to isolate and keep dry a portion of the subsoil to prevent frost heaving and the subsequent misalignment of the critical elements.

Thus, as can be seen, the present system provides a unique method for establishing and maintaining grass play fields with superior long term results and lower overall maintenance and upkeep.

CLAIMS:

1. Grass playing field supporting and sustaining apparatus comprising:
  - a fluid impervious membrane, supported by  
graded subsoil, having upwardly extending edges defining  
5 a section of the field,
    - a layer of gravel supported and contained by  
the membrane allowing lateral flow of liquid therein,  
a layer of sand overlying said layer of gravel  
and within which the grass is growing,  
10 means located within the section and on top of  
the gravel to selectively provide irrigation, or to  
withdraw liquid as needed,  
means for detecting the liquid level in a  
section at a place remote from the section whereby the  
15 liquid level may be controlled and the grass is appropri-  
ately nourished.
2. Apparatus as in Claim 1, wherein the sand has  
well rounded particles and having a majority that range  
in size from 0.25 to 0.60 millimeters.
- 20 3. Apparatus as in Claim 1, wherein the gravel  
particles are no larger than 3/8" and be round in nature.
4. Apparatus as in Claim 1, wherein the quality of  
sand determines the depth, assuring adequate watering

and drainage.

5. Apparatus as in Claim 1, wherein the means for detecting the liquid level comprises a U-tube with one end being embedded within the field and the other exterior thereto.

6. Apparatus as in Claim 5, wherein the end of the U-tube which is exterior to the field includes means for actuating valves to correct the level within the field.

- 10 7. Apparatus as in Claim 1, wherein means is provided to detect any chemical unbalance within the field.

8. A method of sustaining a grass surface comprising:

- 15 a) providing a growing medium which has vertical liquid flow characteristics,  
b) providing a reservoir beneath the growing medium,  
c) controlling the liquid level within the  
20 reservoir to assure continual and adequate water to the grass from beneath.

9. A system for growing and maintaining a grass playing field comprising the steps of:

(a) planting the grass in a growing medium having good vertical flow characteristics to permit good drainage and hydroponic action, said medium overlying material having good lateral flow characteristics  
5 and contained by a fluid impermeable barrier,

(b) continuously applying water to the grass by providing a pool of water within the barrier,

(c) controlling the water level, adding or draining when necessary through conduits within the  
10 layer of material having good lateral flow characteristics.

10. A system as in Claim 9, wherein the entire field is washed when necessary by flooding and completely draining followed by refilling the pool.

15 11. A system as in Claim 9, wherein controlled heat is sufficient to extend the useful and growing season.

12. A system for growing and supporting grass  
for playing fields or the like wherein the grassy  
surface provides firm footing for users of the field,  
is substantially level, is usable a greater amount of time,  
5 over a longer season, and is free from obstructions,  
said system comprising:

fluid impermeable means underlying the grassy  
surface area and extending upwardly about the perimeter  
to define and isolate a basin,

10 drainage means whereby the entire basin may  
be selectively emptied,

conduit means within the basin and beneath  
the grassy surface area for providing fluid necessary  
for healthy growth of the grass plants which form the  
15 grassy surface area,

a first layer of particulate material within  
the basin, adjacent the bottom thereof said material  
having good lateral flow characteristics such that  
fluid within the basin will be evenly distributed through-  
20 out the basin,

a second layer of material overlying the first  
layer, said second layer being of a smaller particulate  
size than the first layer and having good vertical flow  
characteristics such that fluid will quickly drain  
25 through this layer and further will provide fluid from  
the basin to the growing grass by capillary action, and  
means to monitor the fluid within the basin

such that fluid may be added or withdrawn to assure good growing conditions.

13. A system as in Claim 12 wherein the relationship of the size of particulate material in the first and second layers is such that there is very little penetration of the first layer by the second layer material.

14. A system as in Claim 12, wherein the conduit means is located on top of the first layer.

15. A system as in Claim 12, wherein the means to monitor the fluid includes a U-tube with one end located within the confines of the field and one end at a convenient location outside the confines of the field whereby the fluid level within the field may be instantaneously checked.

16. A system as in Claim 12, wherein the means to monitor the fluid includes means to analyze the makeup thereof.

17. A means for controlling the liquid level within a basin which serves as a support system for a turf field, said basin comprising a fluid impermeable means defining the sides and bottom of the basin, filled with a fluid permeable growing medium,

means for uniformly heating the material . .  
within the basin,

means having no moving parts within the basin  
for detecting the fluid level within the basin, and

5 means responsive to the detecting means for  
supplying liquid on an as needed basis.

18. A means as in Claim 17, wherein the liquid  
supply is located beneath the turf.

19. Means as in Claim 17, wherein the growing  
10 medium permits uniform distribution within the basin  
with a minimal lead.

20. A means as in Claim 17, wherein means for  
detecting the fluid level also serves as a means for  
draining the fluid from the basin.



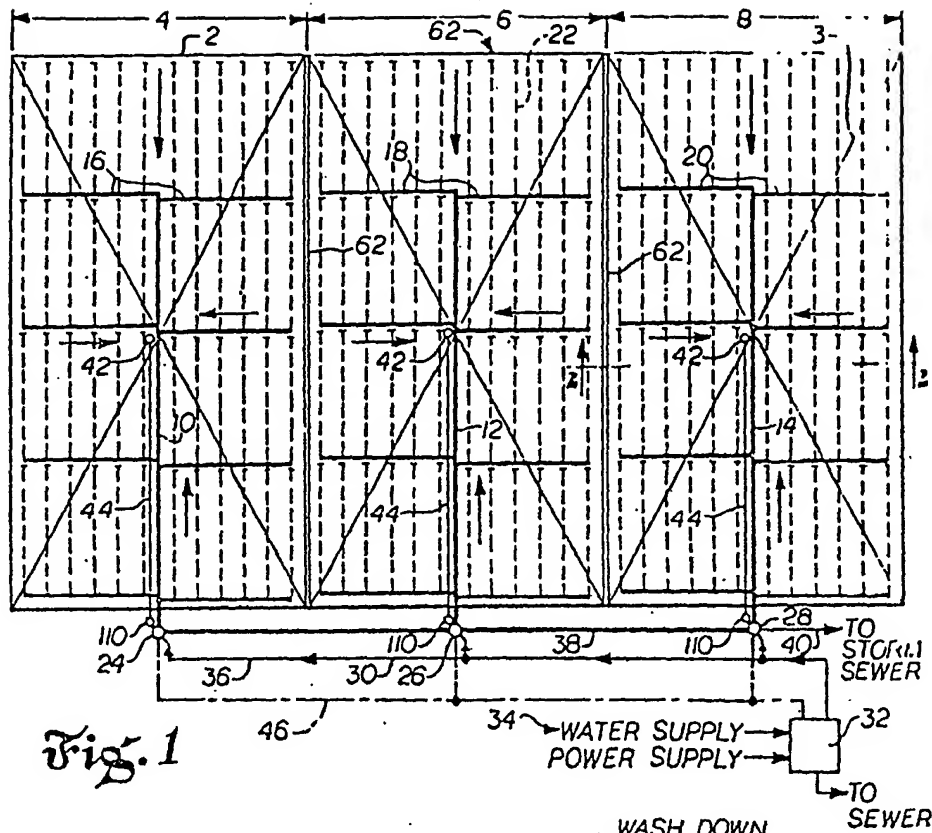


Fig. 1

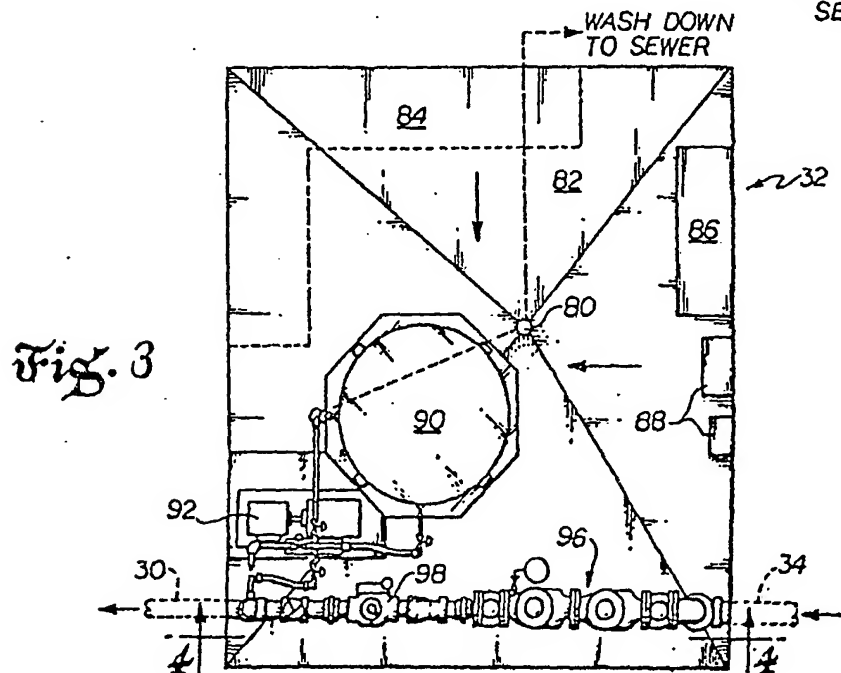
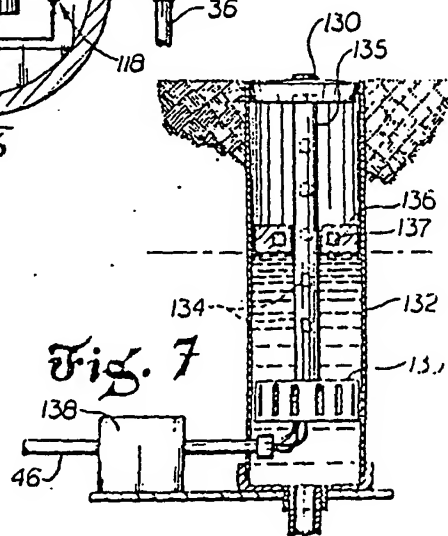
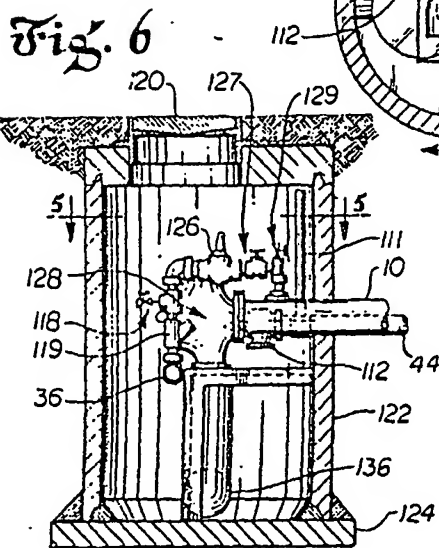
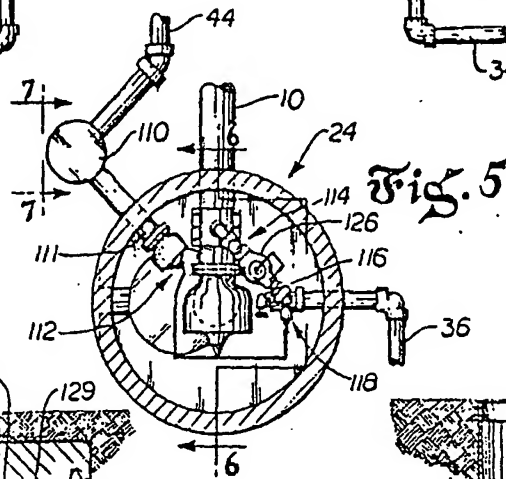
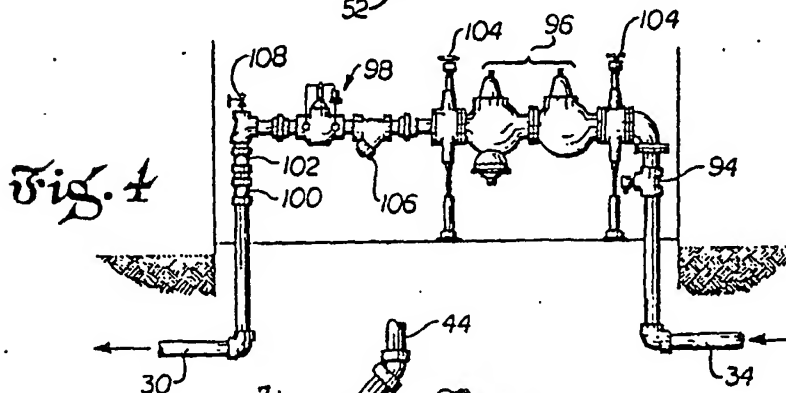
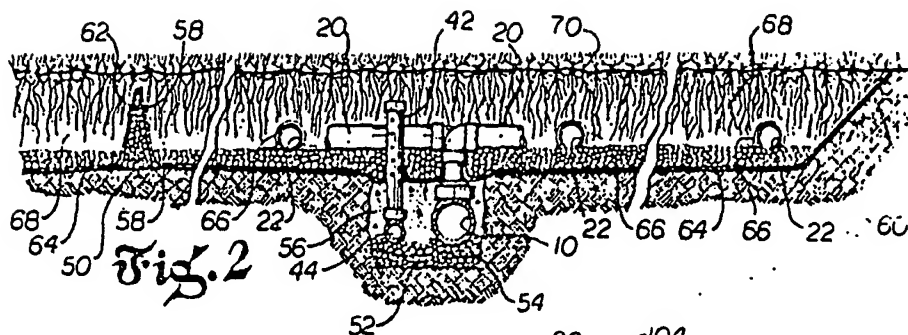


Fig. 3



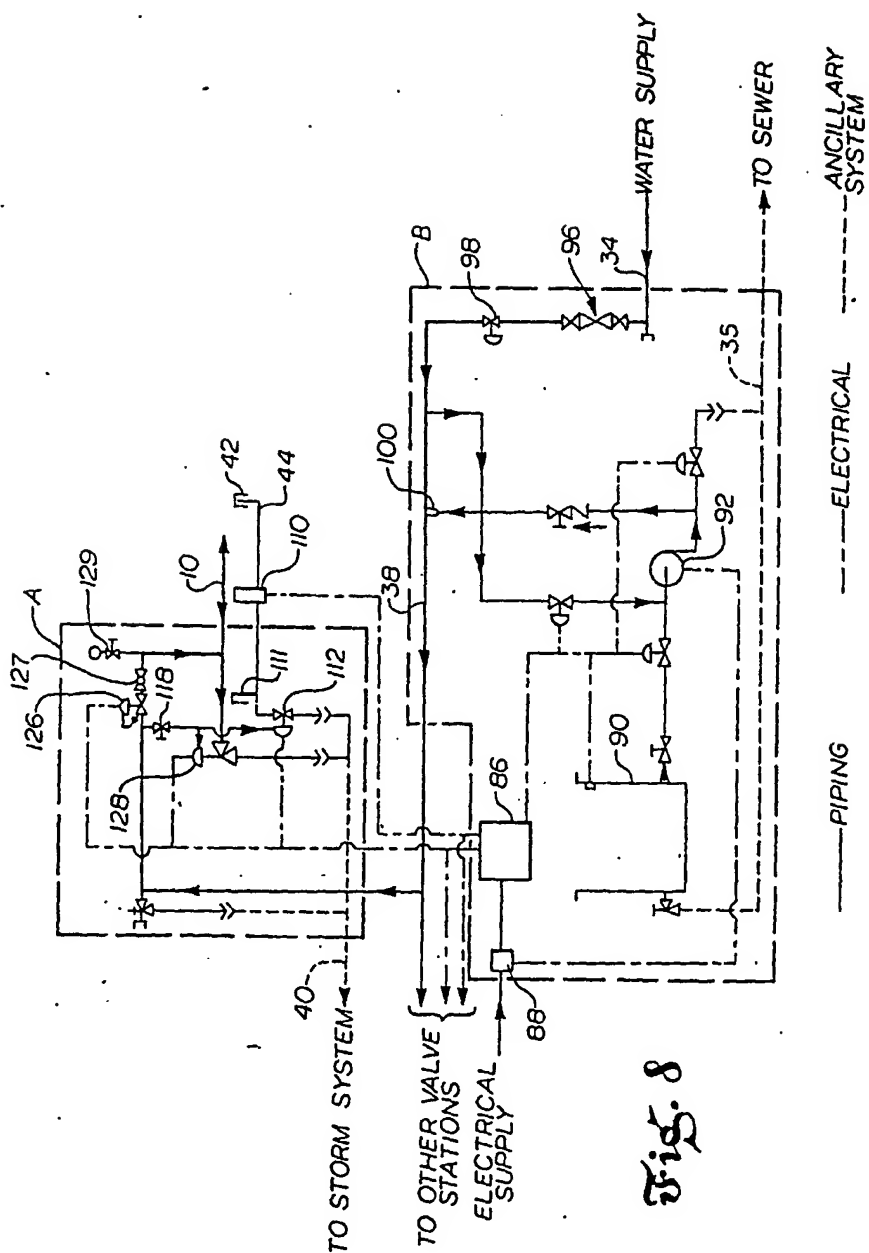


Fig. 8

Fig. 9

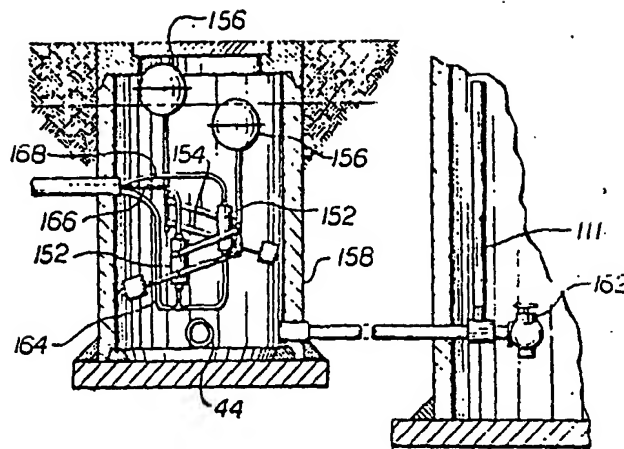
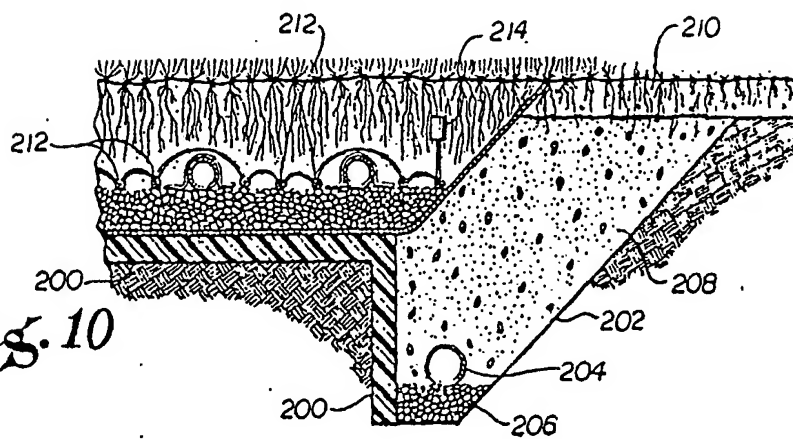


Fig. 10





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# EUROPEAN SEARCH REPORT

0018234  
Application number

EP 80 30 1310.1

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<p>DE - A1 - 2 549 558 (RHEINBAU GMBH) * pages 2 to 8; fig. 1 to 5 *</p> <p>--</p> <p>DE - A1 - 2 627 631 (H. SCHIOLKO) * pages 2 to 4; fig. 1 and 2 *</p> <p>--</p> <p>DE - A - 2 217 338 (CELLSYSTEM) * pages 1 to 8 *</p> <p>--</p> <p>FR - A1 - 2 387 582 (ETS VILBERT-MARBOTTE) * pages 1 to 8; fig. 1 to 8 *</p> <p>--</p> <p>DE - A1 - 2 727 956 (N. BLANK) * pages 3 to 11 *</p> <p>--</p> <p>DE - A1 - 2 727 955 (N. BLANK) * pages 3 to 8 *</p> <p>--</p> <p>DE - A1 - 2 727 954 (N. BLANK) * pages 3 to 8 *</p> <p>--</p> <p>DE - A1 - 2 439 043 (RHEINBAU GMBH) * pages 1 to 10 *</p> <p>--</p> <p>./..</p>	<p>1,5,6, 8,9, 11-15, 17,18, 20</p> <p>1,4,6, 8,9,12, 13,17, 18,20</p> <p>1,5,6, 8,9,11, 12,14, 17,18 20</p> <p>1,5, 6-9,12, 15-20</p> <p>1,4,8, 9,12,13</p> <p>1,6,8, 9,12, 17,20</p> <p>1,9,12</p> <p>1,6,8, 9,11, 12,17, 18</p>	<p>E 01 C 13/00 A 01 G 25/06</p> <p>TECHNICAL FIELDS SEARCHED (Int. Cl.)</p> <p>A 01 G 25/00 E 01 C 13/00</p> <p>CATEGORY OF CITED DOCUMENTS</p> <p>X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons</p> <p>&amp;: member of the same patent family, corresponding document</p>
X The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
Berlin	04-07-1980	PAETZEL	



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0018234  
Application number

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- page 2 -

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D	<u>US - A - 3 461 675</u> (J.P. IZATT) * column 1 to column 4, paragraph 1 *	1,8, 9,12	
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A	<u>FR - A1 - 2 397 491</u> (BOIDIN) * pages 1 to 4 *		
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A	<u>DE - A - 2 029 004</u> (P.A. POULSEN) * page 2, paragraph 2 to page 6 *		TECHNICAL FIELDS SEARCHED (Int. Cl.3)
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A	<u>DE - C - 924 931</u> (F.W. HÄUSSLER) * whole document *		
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A	<u>DE - A - 2 031 187</u> (BROWN, BOVERI & CIE) * pages 1 to 3 *		
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A	<u>DE - A1 - 2 622 063</u> (ENGLISH CLAYS LOVERING POCHIN & CO.) * page 1 to page 8, paragraph 1 *		
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